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Data Sources and Methods for the Freshwater Quality Indicator

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1 Introduction

The Freshwater Quality Indicator (WQI) (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=68DE8F72-1) is a part of the Canadian Environmental Sustainability Indicators (CESI) program (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=47F48106-1), which provides data and information to track Canada's performance on key environmental sustainability issues. This indicator is also used to measure progress towards the goals and targets of the Federal Sustainable Development Strategy (http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1).

2 Description and rationale of the Freshwater Quality Indicator

2.1 Description

The WQI provides an overall measure of the ability of freshwater bodies to support aquatic life at selected monitoring sites across Canada (core sites). It is a water-quality-guideline-driven tool used to distill large amounts of water quality data at a monitoring site into a single index. Water quality at a monitoring site is considered excellent when ambient water quality never, or very rarely, exceeds guidelines for any selected parameters. When water quality is rated poor, water quality measurements usually exceed their guideline; exceedances at these sites may be large.

2.2 Rationale

Clean water is essential to sustain healthy ecosystems and the many benefits they provide us. The WQI provides a national perspective on the overall quality of untreated freshwater for aquatic life in Canada. The WQI assumes that, if measured ambient water quality does not exceed its water quality guideline, it is acceptable for aquatic plants and animals. The WQI provides information about the state of surface freshwater quality and its change through time to inform water resource management.

3 Data

3.1 Data source

Water quality data for 2009 to 2011 were obtained from a number of monitoring programs managed by federal and provincial authorities, as well as by federal-provincial agreements, across the country. The complete list can be found in Annex 1.

Freshwater quality guidelines were obtained from the Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life, the United States Environmental Protection Agency (U.S. EPA), and provincial and territorial sources. A complete list of water quality guidelines used by each jurisdiction can be found in Annex 2.

Drainage regions used in the regional WQI correspond to those defined in Statistics Canada's Standard Drainage Area Classification.[1]

The upstream drainage area of core monitoring sites was delineated using Natural Resources Canada's National Hydro Network.[2]

Human activity in the drainage basin of core monitoring sites was characterized using population density from Statistics Canada's 2006 Census of Population, mine locations using Natural Resources Canada's 2006 Census of Mines, agricultural activity locations using Statistics Canada's 2006 Census of Agriculture, and land cover using Natural Resources Canada's land cover maps.[3,4]

3.2 Spatial coverage

The national WQI is calculated using a set of core sites selected to be representative of surface freshwater quality across Canada and the human pressure exerted on it. The 2009-2011 national WQI was calculated using 172 core sites. The number of core sites can change from one year to the next due to missing data.

The local WQI is reported for the 172 core sites for which 2009-2011 data are available and 162 additional local sites across Canada.

Core site selection

Among Canada's 25 drainage regions, 16 were selected based on population density for the WQI core network (Figure 1). Within the 16 selected drainage regions, core sites were selected to avoid overlapping drainage areas and to ensure sites are independent of one another. The upstream drainage area of monitoring sites was delineated by Statistics Canada using the National Hydro Network.[5] Where upstream drainage areas of monitoring sites overlap, the most downstream site was retained for the core network, as this site is impacted by the maximum area in the river basin and, to some degree, reflects the cumulative impacts of all upstream stresses. For 14 large rivers, including the Athabasca and North Saskatchewan rivers, core sites were established in the upper, mid and lower portions of the river as well as the most downstream sites on each tributary when available. Additional core sites were established on these rivers, as water travels thousands of kilometres from source to mouth. Water quality changes along the way and cannot be summarized by a unique downstream monitoring site. The final selection of core sites ensures monitoring sites are well distributed among provinces, territories and drainage regions and represent land use in the drainage region.

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[1] Statistics Canada (2003) Standard Drainage Area Classification. Retrieved on 17 December, 2013. Available from: http://www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdac-ctad-eng.htm.

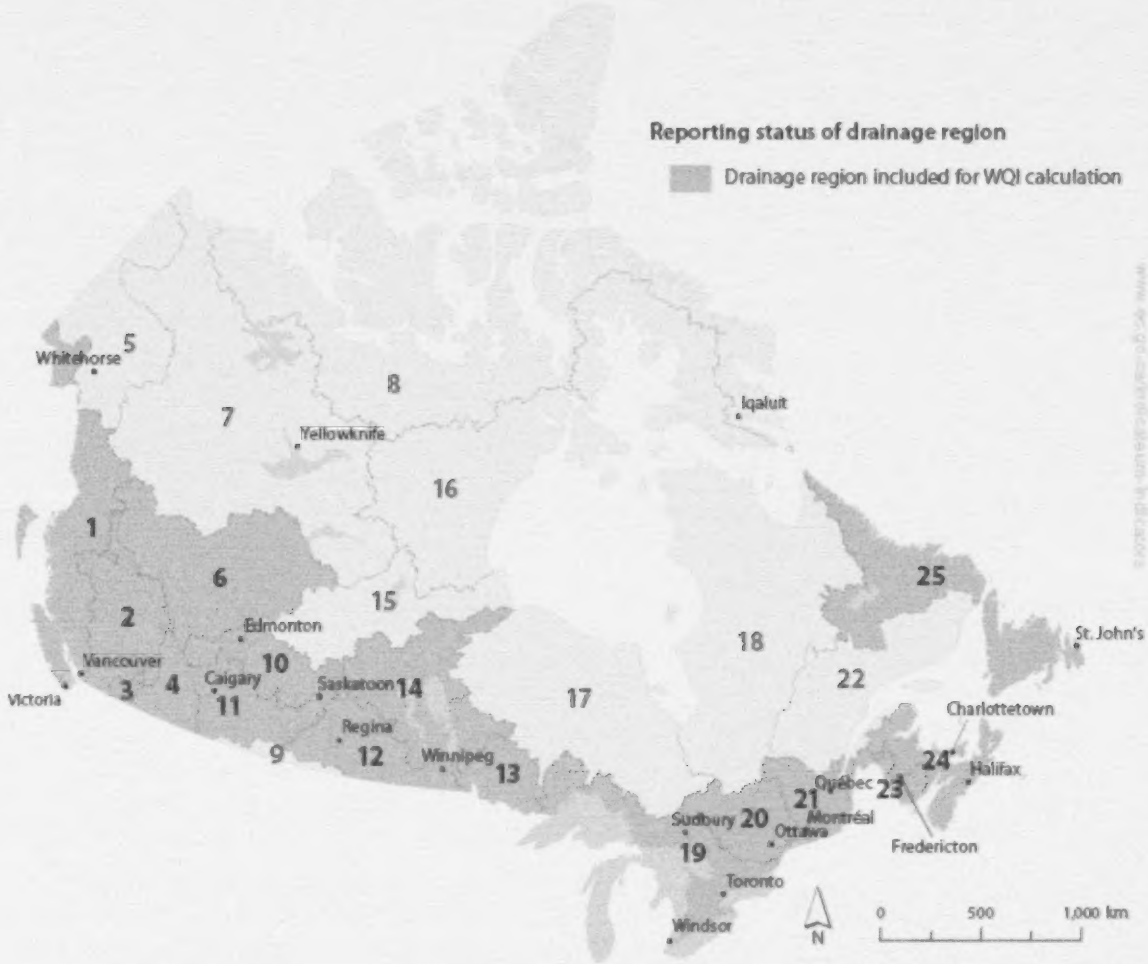
[2] Natural Resources Canada (2007) National Hydro Network, Canada. Retrieved on 17 December, 2013. Available from: http://www.geobase.ca/geobase/en/data/nhn/description.html.

[3] Natural Resources Canada (2005) Multi-Temporal Land Cover Maps of Canada using NOAA AVHRR 1-km data from 1985-2005, 1st edition, Canada Centre for Remote Sensing. Retrieved on 17 December, 2013. Available from: ftp://ftp.ccrs.nrcan.gc.ca/ad/NLCCLandCover/LandcoverCanada1985_2005_1KM/LC85_05_Metadata.html.

[4] Natural Resources Canada (2008) Land Cover Map of Canada 2005, Canada Centre for Remote Sensing. Retrieved on 17 December, 2013. Available from: ftp://ftp.ccrs.nrcan.gc.ca/ad/NLCCLandCover/LandcoverCanada2005_250m/.

[5] Henry M *et al.* (2009) Canadian Environmental Sustainability Indicators: Water Quality Index Representivity Report, Statistics Canada. Retrieved on 17 December, 2013. Available from: http://www.geobase.ca/doc/specs/pdf/GeoBase_NHN_UseCase_StatCan.pdf.

Figure 1: Geographic extent of the 16 drainage regions selected for the core network



1. Pacific Coastal
2. Fraser Lower–Mainland
3. Okanagan–Similkameen
4. Columbia
5. Yukon
6. Peace–Athabasca
7. Lower Mackenzie
8. Arctic Coast–Islands
9. Missouri
10. North Saskatchewan
11. South Saskatchewan
12. Assiniboine–Red
13. Winnipeg
14. Lower Saskatchewan–Nelson
15. Churchill
16. Keewatin–Southern Baffin
17. Northern Ontario
18. Northern Quebec
19. Great Lakes
20. Ottawa
21. St. Lawrence
22. North Shore–Gaspé
23. Saint John–St. Croix
24. Maritime Coastal
25. Newfoundland and Labrador

Water quality was also assessed at monitoring sites known as 'local sites' that were not included in the core network. Information on water quality at individual core and local sites can be found in the CESI interactive freshwater quality map (http://maps-cartes.ec.gc.ca/indicators-indicateurs/default.aspx?lang=en&mapId=3).

3.3 Temporal coverage

The WQI was calculated using a minimum of four samples per year from 2009 to 2011 for southern sites. A minimum of three samples per year is allowed for northern and remote sites because winter access can be difficult. A sensitivity analysis concluded that no significant difference existed in the water quality score when the mid-winter sample was excluded.[6] Three years of data are used to dampen temporal variability in WQI results caused by annual fluctuations in weather and hydrology.[7] By using a three-year roll-up, the WQI is more representative of the overall freshwater quality at a site. It minimizes the effects of events, such as high or low flow, by avoiding one sample driving the WQI score up or down.

Minimum sampling requirements were not met at 10 core sites: 9 in Manitoba and 1 in New Brunswick. The sites are remote, making sampling during the winter months difficult, dangerous and costly. These sites, however, were closely evaluated by local water quality experts, and were included because the data were consistent with previous years and were considered representative of local water quality.

Sample timing and frequency varies among monitoring sites and is set according to the monitoring program objectives. There are up to 131 samples for a given parameter at some sites.

3.4 Data completeness

Data quality assurance/quality control (QA/QC) is performed within each monitoring program providing data for the WQI. Each monitoring program follows standardized methods for sample collection in the field. Chemical analyses are performed in Canadian laboratories accredited by the Canadian Association for Laboratory Accreditation or the Standards Council of Canada.

The data undergo an additional QA/QC process by Environment Canada to ensure the dataset meets minimum data requirements and that standards for calculation are respected. This process leads to removal of parameters due to low sampling frequencies or because detection limits are higher than guidelines used in the calculation. Unusually high or low values in the monitoring datasets are double-checked and confirmed through consultation with the data provider. WQI scores and site information from the monitoring programs are stored in a central WQI dictionary, which facilitates the verification of the number of samples, sample timing and the location of monitoring sites, and calculations.

3.5 Data timeliness

The WQI was calculated using data from 2009 to 2011, the most recent data available from all monitoring programs. For 10 core sites, data from late December 2008 or early January 2012 were used to meet requirements for minimum number of samples.

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[6] Statistics Canada (2007) Behaviour Study on the Water Quality Index of the Canadian Council of Ministers of the Environment. Retrieved on 17 December, 2013. Available from: http://www.statcan.gc.ca/pub/16-001-m/16-001-m2007003-eng.htm.

[7] Government of Canada (2008) Technical guidance document for Water Quality Indicator practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative 2008, p.15-16. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

4 Methods

4.1 Computing the Water Quality Index

The WQI is calculated using the Water Quality Index as endorsed by the CCME.[8] The CCME Water Quality Index consists of three factors: scope, frequency and amplitude (equation 1).[9] Scope (F1) refers to the percentage of parameters where water quality guidelines are not met; frequency (F2) refers to the percentage of samples where water quality guidelines are not met; and amplitude (F3) refers to the amount by which the water quality guidelines are not met. The score is normalized to produce a score between 1 and 100.

$$\text{CCME Water Quality Index} = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right) \quad \text{(Equation 1)}$$

Scores are categorized into five categories, which are defined based on the best available information, expert judgement and the general public's expectations of water quality (Table 1).[10] The WQI adopts the CCME's water quality index categorization.

Table 1: Score rankings for the CCME Water Quality Index

Ranking	Interpretation
Excellent (95.0 to 100.0)	Water quality measurements never or very rarely exceed water quality guidelines.
Good (80.0 to 94.9)	Water quality measurements rarely exceed water quality guidelines and, if they do, it is usually by a narrow margin.
Fair (65.0 to 79.9)	Water quality measurements sometimes exceed water quality guidelines and may do so by a wide margin.
Marginal (45.0 to 64.9)	Water quality measurements often exceed water quality guidelines and/or exceed the guidelines by a considerable margin.
Poor (0 to 44.9)	Water quality measurements usually exceed water quality guidelines and/or exceed the guidelines by a considerable margin.

4.2 Parameter selection

Provincial and territorial water quality experts select parameters, or chemical substances and physical properties, to be assessed based on knowledge of local water quality stressors. A selection of 8 to 12 parameters per monitoring site is recommended to ensure comparability and consistency in a parameter's relative influence on the final WQI ranking.[11] Typically, at least one form of the following parameters groups is reported at each monitoring site:

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[8] Canadian Council of Ministers of the Environment (2001) CCME Water Quality Index 1.0 User's Manual. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/assets/pdf/wqi_usermanualfctsht_e.pdf.

[9] Canadian Council of Ministers of the Environment (2001) CCME Water Quality Index 1.0 Technical Report. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/assets/pdf/wqi_techrprtfctsht_e.pdf.

[10] Canadian Council of Ministers of the Environment (2001) CCME Water Quality Index 1.0 User's Manual. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/assets/pdf/wqi_usermanualfctsht_e.pdf.

[11] Canadian Council of Ministers of the Environment (2006) A sensitivity analysis of the Canadian Water Quality Index. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/publications/list_publications.html#link9.

nutrients (e.g., phosphorus, nitrate, nitrite, total nitrogen), metals (e.g., zinc, copper, lead), physico-chemical parameters (e.g., pH, turbidity) and 2 to 4 regionally specific parameters (e.g., chloride, ammonia, dissolved oxygen, pesticides).[12] In calculating the WQI, between 5 and 15 parameters are used to assess water quality at each monitoring site. A sample value must be available for each year for at least 33% of the total number of samples in order for a parameter to be included in the WQI.

For all monitoring programs, except British Columbia and Yukon, a common suite of parameters is assessed at all monitoring sites, with site-specific parameters added as required. In British Columbia and Yukon, a site-specific selection of parameters is carried out with dissolved oxygen, phosphorus, pH, nitrogen, water temperature and other site-specific parameters included when available. Annex 2 lists all parameters measured in each province and territory. The CESI interactive water quality map (http://maps-cartes.ec.gc.ca/indicators-indicateurs/default.aspx?mapId=3&lang=en) lists parameters at each individual site.

In British Columbia and Yukon, metals data may be excluded from the indicator dataset when samples are collected during periods of high turbidity. For these sites, the turbidity cut-off is assessed based on long-term monitoring data, to take into consideration site-specific conditions. A site-specific water quality guideline is calculated for a particular metal based on the 5th percentile of long-term monitoring data for hardness.[13] A turbidity cut-off is calculated by assessing turbidity associated with the identified water quality guideline through a regression analysis of long-term turbidity and metal data specific to that site. In these two jurisdictions, metal data are discarded from the indicator calculations during high-turbidity events on the basis that these occurrences of short-term exposure pose low risk to aquatic life. Trimming data based on high-turbidity events also improves the association between the WQI and indices of benthic community composition, improving the assessment of risk to aquatic life.[14]

4.3 Water quality guideline selection

Water quality guidelines are recommended numerical limits or narrative statements for a variety of chemical substances and physical parameters, which, if exceeded, may impair aquatic life. They are based on existing knowledge of a substance's environmental fate and behaviour, and its chronic or acute toxicity. The WQI uses chronic water quality guidelines for the protection of aquatic life. Quebec uses acute water quality guidelines for metals.

Water quality guidelines are selected to be locally relevant, and different water quality guidelines are used among and within provinces and territories. The Canadian Water Quality Guidelines for the Protection of Aquatic Life developed by the CCME are recommended if locally relevant.[15] Other sources of guidelines include the U.S. EPA or provincial or territorial

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[12] British Columbia Ministry of Environment (1997) Methods for deriving site-specific water quality objectives in British Columbia and Yukon. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/effects_ratio/effectsratio.html.

[13] Metal water quality guidelines are defined on the basis of ambient pH or hardness concentrations because these parameters affect the bioavailability of metals in the water. For details on the definition of metal guidelines, please consult Annex 1 and associated sources cited for each guideline.

[14] Canadian Council of Ministers of the Environment (2009) Reducing the Sensitivity of the Water Quality Index to Episodic Events. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/publications/list_publications.html#link9.

[15] Canadian Council of Ministers of the Environment (undated) Canadian Water Quality Guidelines for the Protection of Aquatic Life. Retrieved on 17 December, 2013. For a complete list of guidelines, consult the Factsheets section. Available from: http://ceqg-rcqe.ccme.ca/.

environment departments. Provincial or territorial water quality experts select the guidelines to use in the WQI. Annex 2 provides a complete list of guidelines used by provinces and territories, and their source.

Background concentrations of naturally occurring substances and other local river characteristics can affect the measured concentration and toxicity of certain substances. In these cases, site-specific guidelines (SSG) are developed using background concentration procedures[16] or a rapid assessment approach.[17] The rapid assessment approach uses long-term monitoring data, and corrects for natural events, such as high flows, that may influence results.

4.4 Classification of sites according to human activity

The drainage area of each monitoring site was delineated using the National Hydro Network.[18] Human activity was assessed in the drainage area of core sites and classified according to the criteria presented in Table 2. Data sources are detailed in section 3.1. Agricultural land cover corresponds to land cover classes 26, 27, 28 and 29. Undisturbed land cover corresponds to land cover classes 0, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 31, 32, 33 and 38. A full description of land cover classes is available in the land cover database of Canada.[19]

Land use in the drainage area of 16 core sites in Newfoundland and Labrador and Quebec was defined by the organization responsible for the monitoring program based on local knowledge of the drainage area. Land use for two sites in British Columbia was not classified, because they are transboundary sites and the U.S. portion of the sites' catchment is difficult to classify.

Table 2: Criteria for the classification of human activity at monitoring sites

Land use	Criteria
Agriculture	> 20% of drainage area is agricultural land cover
Mining	Presence of at least one mine
Mixed	Agriculture and Mining OR Agriculture and Population density >25 persons/km^2 OR Mining and Population density > 50 persons/km^2
Remote	> 95% of drainage area is undisturbed land cover

[16] Canadian Council of Ministers of the Environment (2003) Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives. Retrieved on 17 December, 2013. Available from: http://ceqg-rcqe.ccme.ca/download/en/221/.

[17] Government of Canada (2008) Technical guidance document for Water Quality Indicator practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative 2008, p.15-16. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

[18] Henry M *et al.* (2009) Canadian Environmental Sustainability Indicators: Water Quality Index Representivity Report, Statistics Canada. Retrieved on 17 December, 2013. Available from: http://www.geobase.ca/doc/specs/pdf/GeoBase_NHN_UseCase_StatCan.pdf.

[19] Natural Resources Canada (2008) Land Cover Map of Canada 2005, Canada Centre for Remote Sensing. Retrieved on 17 December, 2013. Available from: ftp://ftp.ccrs.nrcan.gc.ca/ad/NLCCLandCover/LandcoverCanada2005_250m/.

To evaluate if land use had a significant effect on the WQI score, a chi-square test of independence was performed. The poor and marginal categories and good and excellent categories were grouped for this test to produce adequate sample sizes. The relationship between water quality categories and land use was statistically significant ($X^2 = 38.3$, $df = 6$, $P < 0.001$).

4.5 Addressing changes in the indicator through time

A subset of 101 sites from 16 drainage regions was selected from the core network to assess changes in the WQI through time. This subset corresponds to all core sites with data available from 2003 to 2011. Changes in water quality were measured by assessing change between the 2003-05 and 2009-11 reporting periods. The 2003-05 period was selected as the starting point of the change analysis as it was the first period with sufficient data available for the analysis.

For this analysis, WQI scores for 2003-05 were recalculated using parameters and guidelines used in the 2009-11 WQI. Guidelines and parameter selection have evolved over time. Harmonizing parameters and guidelines avoids mistaking methodological changes for water quality change. When historical data were missing for a parameter, the parameter was dropped from the calculation of the score for both periods. Quebec has changed the form of ammonia that it is reporting: the province now reports un-ionized ammonia instead of dissolved ammonia and there is no way to convert between the two forms. The ammonia data in the older data set were left as dissolved ammonia for this analysis.

Confidence intervals were computed for freshwater quality scores using a non-parametric bootstrapping method.[20] To compute the confidence interval for a given site, a simulation of 10 000 scores was performed. For each iteration, the parameter suite measured for a given date is resampled randomly from all measurements taken from the same site, and a simulated score is calculated. The confidence interval corresponds to the 95th percentile of the distribution of simulated scores.

A change in the WQI was considered significant at a site when no overlap existed between confidence intervals for 2003-05 and 2009-11 scores. A count of sites with improving, deteriorating and unchanged WQI was compiled for the indicator of change through time.

5 Caveats and limitations

The ability of the WQI to provide information about freshwater quality relies in large part on the suitability of water quality guidelines. Freshwater quality guidelines are derived from laboratory data that do not consider the impact of flow on sediment loads in a river. Although site-specific guidelines attempt to remove the impact of elevated flows on parameter concentrations, elevated levels of naturally occurring substances, such as minerals, nutrients, glacier deposits and soils, can lower water quality ratings.

The WQI does not directly measure biological integrity; it measures whether physical and chemical characteristics of freshwaters are acceptable for aquatic life. Although physical and chemical measurements provide good proxies of biological quality, only biological information provides a direct measurement of conditions for aquatic life.

The WQI only assesses the quality of surface waters. Groundwater is not considered in this indicator.

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[20] El Shaarawi AM (2011) Environmental Indicators: Their development and Application. Environment Canada.

The WQI reflects the overall state of water quality and does not show the impact of spills or other transient events unless these are frequent or long-lasting.

The selection of core sites is intended to represent freshwater quality in the portion of Canada where the majority of Canadians live. Monitoring sites used to calculate this indicator do not cover all potential water quality issues in Canada. Northern Canada is under-represented in the WQI.

The WQI allows flexibility in the selection of parameters and guidelines. This flexibility allows local and regional water quality concerns to be reflected in the indicator. Because differences in parameters and guidelines occur among monitoring sites and jurisdictions, direct comparisons cannot be made among jurisdictions.

Analytical limitations, and time requirements for the development of water quality guidelines, affect the selection of parameters. Only parameters for which water quality guidelines exist can be included in the indicator. However, the absence of a water quality guideline for a parameter does not mean the parameter is unimportant.

The WQI is sensitive to the number of parameters and samples used in its calculation. The number of parameters varies from 5 to 15 depending on the monitoring site, and between 9 and 60 samples can be used for a given parameter. In general, as the number of parameters or samples used to calculate the index increases, the WQI score tends toward the middle. Thus, adding samples to a Poor site will increase the number of parameters that pass, increasing the score. Conversely, at an Excellent site, adding samples will increase the chance one will fail, lowering the score.[21]

The change-through-time analysis includes 101 sites. It does not have the same representativeness of Canadian surface water quality as the national indicator because many core sites began sampling after 2003.

Freshwater quality varies naturally with precipitation levels. Although the WQI uses a three-year rolling average to dampen the influence of rain and snowfall on the WQI score, care must be taken in comparing one period to another. Long-term trends analysis is considered to be more meaningful than a simple year to year comparison.

6 References and further reading

6.1 References

British Columbia Ministry of Environment (1997) Methods for deriving site-specific water quality objectives in British Columbia and Yukon. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/effects_ratio/effectsratio.html.

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[21] Statistics Canada (2007) Behaviour Study on the Water Quality Index of the Canadian Council of Ministers of the Environment. Retrieved on 17 December, 2013. Available from: http://www.statcan.gc.ca/pub/16-001-m/16-001-m2007003-eng.htm.

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Canadian Council of Ministers of the Environment (2006) A sensitivity analysis of the Canadian Water Quality Index. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/publications/list_publications.html#link9.

Canadian Council of Ministers of the Environment (2009) Reducing the Sensitivity of the Water Quality Index to Episodic Events. Retrieved on 17 December, 2013. Available from: http://www.ccme.ca/publications/list_publications.html#link9.

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Henry M *et al.* (2009) Canadian Environmental Sustainability Indicators: Water Quality Index Representivity Report, Statistics Canada. Retrieved on 17 December, 2013. Available from: http://www.geobase.ca/doc/specs/pdf/GeoBase_NHN_UseCase_StatCan.pdf.

Natural Resources Canada (2005) Multi-Temporal Land Cover Maps of Canada using NOAA AVHRR 1-km data from 1985-2005, 1st edition, Canada Centre for Remote Sensing. Retrieved on 17 December, 2013. Available from: ftp://ftp.ccrs.nrcan.gc.ca/ad/NLCCLandCover/LandcoverCanada1985_2005_1KM/LC85_05_Metadata.html.

Natural Resources Canada (2007) National Hydro Network, Canada. Retrieved on 17 December, 2013. Available from: http://www.geobase.ca/geobase/en/data/nhn/description.html.

Natural Resources Canada (2008) Land Cover Map of Canada 2005, Canada Centre for Remote Sensing. Retrieved on 17 December, 2013. Available from: ftp://ftp.ccrs.nrcan.gc.ca/ad/NLCCLandCover/LandcoverCanada2005_250m/.

Statistics Canada (2007) Behaviour Study on the Water Quality Index of the Canadian Council of Ministers of the Environment. Retrieved on 17 December, 2013. Available from: http://www.statcan.gc.ca/pub/16-001-m/16-001-m2007003-eng.htm.

Statistics Canada (2009) Standard Drainage Area Classification (SDAC) 2003. Retrieved on 17 December, 2013. Available from: http://www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdacinfo2-ctadinfo2-eng.htm.

Annex 1: Monitoring programs providing data on ambient water quality

Province/territory	Monitoring program	Organization(s)
Alberta	Long-term River Network monitoring program	Alberta Environment and Sustainable Resource Development
	Prairie Provinces Water Board	Environment Canada, Alberta Environment and Sustainable Resource Development
British Columbia	Canada-British Columbia Water Quality Monitoring Agreement	British Columbia Ministry of Environment, Environment Canada
British Columbia and Yukon	Federal Water Quality Monitoring Program	Environment Canada, Parks Canada
Manitoba	Prairie Provinces Water Board, Canada-Manitoba Water Quality Monitoring Agreement	Environment Canada, Manitoba Water Stewardship
	International Red River Board, Federal Water Quality Monitoring Program	International Red River Board, including Environment Canada and Manitoba Water Stewardship
	Ambient water quality monitoring network	Manitoba Water Stewardship
New Brunswick	Canada-New Brunswick Water Quality Monitoring Agreement	Environment Canada, New Brunswick Department of Environment
	Long-range Transport of Atmospheric Pollutants Program	Environment Canada
	Surface water monitoring network, National Parks project	New Brunswick Department of Environment and local government
Newfoundland and Labrador	Canada-Newfoundland and Labrador Water Quality Monitoring Agreement	Environment Canada, Newfoundland and Labrador Department of Environment and Conservation
Nova Scotia	Long-range Transport of Atmospheric Pollutants Program	Environment Canada
	Nova Scotia Automated Surface Water Quality Monitoring Network	Nova Scotia Environment
	Federal Surface Water Quality Monitoring Network	Environment Canada
Ontario	Provincial Water Quality Monitoring Network	Ontario Ministry of the Environment
Prince Edward Island	Canada-Prince Edward Island Water Quality Agreement	Environment Canada, Prince Edward Island Department of Environment, Energy and Forestry

Province/territory	Monitoring program	Organization(s)
Quebec	Réseau-Rivières	Ministère du Développement durable, de l'Environnement et des Parcs du Québec
	The State of the St. Lawrence Monitoring Program	Environment Canada
Saskatchewan	Prairie Provinces Water Board	Environment Canada, Saskatchewan Ministry of Environment
	Souris River Bilateral Agreement, Federal Water Quality Monitoring Program	International Souris River Board, including Environment Canada and Manitoba Water Stewardship
	Saskatchewan Ministry of Environment Surface Water Quality Monitoring Program	Saskatchewan Ministry of Environment
Northwest Territories and Nunavut	Environment Canada northern long-term water quality monitoring network; Alberta-Northwest Territories transboundary rivers water quality monitoring program; Parks Canada Western Arctic Parks water quality monitoring program (Aulavik & Tuktut Nogait); Environment Canada-Parks Canada water quality monitoring program in Eastern Arctic Parks (Quttinirpaaq & Auyuittuq); Environment Canada-Parks Canada water quality monitoring program in Nahanni National Park; Aboriginal Affairs and Northern Development Canada water quality programs in the Northwest Territories basins (Coppermine, Yellowknife, Lockhart, Slave, Hay, Liard, Peel, Snare, Burnside River basins)	Environment Canada, Aboriginal Affairs and Northern Development Canada, Parks Canada, Alberta Environment, Government of Northwest Territories (Environment and Natural Resources), Government of Nunavut (Department of Environment)
Yukon	Canada-Yukon Water Quality Monitoring Network; Parks Canada Western Arctic Parks water quality monitoring program (Ivvavik National Park)	Yukon Environment, Environment Canada, Parks Canada

Annex 2: Water quality guidelines used in each jurisdiction

Alberta

Parameter	Form	Guideline	Source
2,4-D[1]	total	4 µg/L	a
Aluminium[1]	dissolved	0.005 mg/L for pH < 6.5 0.1 mg/L for pH ≥ 6.5	b
Ammonia	un-ionized	19 µg/L	b
Arsenic	total	5 µg/L	a
Cadmium[1]	total	$e^{1.0166*\ln[\text{hardness}]-3.924}$ µg/L where hardness as mg [$CaCO_3$]/L	c
Chloride[2]	dissolved	120 mg/L	a
Copper[1]	total	7 µg/L	d
Copper[2]	total	2 µg/L for hardness < 90 mg [$CaCO_3$]/L $e^{0.8545*\ln[\text{hardness}]-1.465} * 0.2$ µg/L for hardness > 90 mg [$CaCO_3$]/L where hardness as mg [$CaCO_3$]/L	b
Lead	total	< $e^{1.273*\ln[\text{hardness}]-4.705}$ µg/L where hardness as mg [$CaCO_3$]/L	d
MCPA[1]		2.6 µg/L	a
Mercury[1]	total inorganic	0.026 µg/L	a
Nickel[2]	total	$e^{0.76*\ln[\text{hardness}]+1.06}$ µg/L where hardness as mg [$CaCO_3$]/L	b
Nitrogen	total	1 mg N/L	d
Oxygen	dissolved	6.5 mg/L	a d
pH[2]		between 6.5 and 9	a
Phosphorus	total	0.05 mg/L	d e
Selenium[1]	total	2 µg/L	b
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [$CaCO_3$]/L 7.5 + 0.75*(hardness-90) for hardness > 90mg [$CaCO_3$]/L	b

[1] Applies to sites monitored under provincial monitoring programs.
[2] Applies to sites monitored under federal monitoring programs, including the Prairie Provinces Water Board.

Alberta Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

c United States Environmental Protection Agency (2001) 2001 Update of Ambient Water Quality Criteria for Cadmium. Document EPA 822-R-01-001. Retrieved on 17 December, 2013. Available from: http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/cadmium/cadfacts.cfm.

d Alberta Environment (1999) Surface water quality guidelines for use in Alberta. Retrieved on 17 December, 2013. Available from: http://environment.alberta.ca/01323.html.

e Prairie Provinces Water Board (1992) Master Agreement on Apportionment. Schedule E: Agreement on Water Quality. Retrieved on 17 December, 2013. Available from: http://www.ppwb.ca/information/115/index.html.

British Columbia

Parameter	Form	Guideline	Source
Alkalinity		20 mg [$CaCO_3$]/L	a
Arsenic	total	5 µg/L	b
Cadmium	total	$10^{(86\log10[\text{hardness}]-3.2\ \mu g/L)}$ for hardness > 50 mg [$CaCO_3$]/L0.019 µg/L for hardness < 50 mg [$CaCO_3$]/L SSG[1] (certain sites)	b c
Chloride	total dissolved	120 mg/L	b
Chromium	total	SSG[1]	a c e f g j i l m
Copper	total	2 µg/L for hardness < 90 mg [$CaCO_3$]/L $0.2e^{0.8545*\ln[\text{hardness}]-1.465*}$ for hardness > 90 mg [$CaCO_3$]/L where hardness as mg [$CaCO_3$]/L SSG[1]	d e j l m n
Cyanide	weak acid dissociable	5 µg/L	b
Fluoride	total	0.3 mg/L (BC08NM001), 0.35 mg/L (BC08NN0021)	o
Iron	total	0.3 mg/L	d
Lead	total	1 ug/L when hardness < 50 mg [$CaCO_3$]/L, $e^{1.273*\ln[\text{hardness}]-4.705}$ µg/L when hardness < 50 mg [$CaCO_3$]/L SSG[1]	d p
Manganese	total dissolved	SSG[1]	k q
Molybdenum	total	73 ug/L	b r
Nickel	total	$e^{0.76*\ln[\text{hardness}]+1.06\ \mu g/L}$	d
Nitrate	total dissolved	2.93 mg N/L	d
Nitrite	total	0.02 mg N/L	s
Nitrogen	total, total dissolved	0.7 mg/L	s
Oxygen	dissolved	SSG[1]	b t u

Parameter	Form	Guideline	Source
pH		SSG[1]	b c m t
Phosphorus	total and total dissolved	0.025 mg/L	d v
Selenium	total dissolved	2 µg/L	d w
Silver	total	0.05 µg/L for hardness < 100 mg [$CaCO_3$]/L 1.9 µg/L for hardness > 100 mg [$CaCO_3$]/L where hardness as mg [$CaCO_3$]/L SSG[1]	d x
Sulphate	dissolved	50 mg/L	y
Temperature		SSG[1]	z
Thallium	total	0.8 µg/L	b
Uranium	total	10 µg/L	a
Zinc	total	7.5 µg/L	c e j k aa

[1] SSG denotes that different site-specific guidelines or formulas were used at sites. For details on the derivation of site-specific guidelines, consult BCMOE (1997). [ab]

British Columbia Water Quality Guideline Sources:

a British Columbia Ministry of Environment (2006) A compendium of working water quality guidelines for British Columbia. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/working.html.

b Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

c Butcher GA (1992) Lower Columbia River, Hugh Keeleyside dam to Birchbank water quality assessment and objectives: Technical appendix. British Columbia Ministry of the Environment, Lands and Parks. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/objectives/lowcolum/Keenleysidetech.pdf.

d Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

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f Environment Canada (2005) Site-specific water quality guidelines for the Beaver River at Park Gate Highway 1 for the purpose of national reporting. Tri-Star Environmental Consulting.

g Environment Canada (2005) Site-specific Water Quality Guidelines for the Kicking Horse River above Field, BC for the purpose of national reporting. Tri-Star Environmental Consulting.

h Environment Canada (2005) Site-specific Water Quality Guidelines for the Kootenay River at Kootenay Crossing for the purpose of national reporting. Tri-Star Environmental Consulting. Retrieved on 17 December, 2013. Available from: http://waterquality.ec.gc.ca/WaterQualityWeb/PDFDocs/BC08NF0001%20-%20kootenay%20at%20kootenay%20crossing.pdf.

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k Swain LG (1990) Okanagan area, Similkameen River sub-basin water quality assessment and objectives. British Columbia Ministry of Environment. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/objectives/similkameen2/similkameen2.html#ccip.

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m British Columbia Ministry of Water, Land and Air Protection (1997) Water quality assessment and objectives for the Fraser River from Moose Lake to Hope. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/objectives/frasermoose/Moosehopetech.pdf.

n British Columbia Ministry of Water, Land and Air Protection (2004) Water quality assessment and objectives for the Elk River for the purpose of national reporting.

o Warrington PD (1995) Ambient water quality criteria for fluoride. British Columbia Ministry of Environment. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/fluoride/index.html.

p British Columbia Ministry of Environment (1987) Water quality criteria for lead: overview report. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/lead/lead.html.

q Nagpal NK (2001) Ambient water quality guidelines for manganese: Overview report. British Columbia Ministry of Environment. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/manganese/manganese.html.

r Environment Canada (2005) Site-specific Water Quality Guidelines for the Sumas River at the international boundary for the purpose of national reporting. Tri-Star Environmental Consulting. Retrieved on 17 December, 2013. Available from: http://waterquality.ec.gc.ca/WaterQualityWeb/PDFDocs/BC08MH0027%20-%20sumas.pdf.

s Nordin RN and Pommen LW (2001) Water quality criteria for nitrogen (nitrate, nitrite, and ammonia): Overview report. British Columbia Ministry of Environment and Parks. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/nitrogen/nitrogen.html.

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v Ontario Ministry of the Environment and Energy (1994) Water management policies, guidelines, provincial water quality objectives. Retrieved on 17 December, 2013. Available from: https://archive.org/details/watermanagementp00ontauoft.

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Manitoba

Parameter	Form	Guideline	Source
2,4-D		4 µg/L	a
Ammonia[1]	total as N	Calculation based on pH and temperature	b c
Ammonia[2]	un-ionized	19 µg/L	d
Arsenic[1]	extractable, total	150 µg/L	e
Arsenic[2]	total	5 µg/L	a
Cadmium[1]	extractable, total	$[e^{0.7409\ln[\text{hardness}]-4.719}] \times [1.101672 - \{\ln(\text{hardness})(0.041838)\}]$ µg/L where hardness as mg $[CaCO_3]/L$]	f
Chloride[2]	dissolved	120 mg/L	a
Copper[1]	extractable, total	$[e^{0.8545\ln[\text{hardness}]-1.702}] \times (0.96)$ µg/L where hardness as mg $[CaCO_3]/L$	b
Copper[2]	total	2 µg/L for hardness < 90 mg $[CaCO_3]/L$ $[e^{0.8545\ln[\text{hardness}]-1.465}] \times (0.2)$ µg/L for hardness >90 mg $[CaCO_3]/L$ where hardness as mg $[CaCO_3]/L$]	d
Iron[1]	total	0.3 mg/L	d
Lead	extractable, total	$[e^{1.273\ln[\text{hardness}]-4.705}] \times [1.46203 - \{\ln(\text{hardness})(0.145712)\}]$ µg/L where hardness as mg $[CaCO_3]/L$	d
MCPA		2.6 µg/L	a
Nickel[1]	extractable, total	$[e^{0.8460\ln[\text{hardness}]+0.0584}] \times [0.997]$µg/L where hardness as mg $[CaCO_3]/L$	e
Nitrate[1]	total dissolved	2.9 mg N/L	d
Nickel[2]	total	$< e^{0.76[\ln(\text{hardness})]+1.06}$ µg/L where hardness as mg $[CaCO_3]/L$	d
Nitrogen[2]	total	1 mg N/L	h
Oxygen[1]	dissolved	5 mg/L	e
Oxygen[2]	dissolved	6.5 mg/L	a
pH		between 6.5 and 9	a
Phosphorus	total	0.05 mg/L	b g
Suspended sediments[1]	total	Maximum increase of 25 mg/L for high flow and turbid waters above background levels	d
Zinc[1]	total	$[e^{\{0.8473\ln[\text{hardness}]+0.884\}}] \times [0.986]$ µg/L where hardness as mg $[CaCO_3]/L$	b f
Zinc[2]	total	7.5 µg/L for hardness ≤ 90 mg $[CaCO_3]/L$ 7.5 + 0.75*(hardness-90) for hardness > 90 mg $[CaCO_3]/L$ where hardness as mg $[CaCO_3]/L$	d

[1] Applies to sites monitored under provincial monitoring programs.
[2] Applies to sites monitored under federal monitoring programs (Prairie Provinces Water Board).

Manitoba Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Manitoba Water Stewardship (2011) Manitoba water quality standards, objectives, and guidelines. Retrieved on 17 December, 2013. Available from: http://www.gov.mb.ca/waterstewardship/water_quality/quality/pdf/mb_water_quality_standardconsultation_draft.pdf.

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d Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

e United States Environmental Protection Agency (2009) National Recommended Water Quality Criteria. Retrieved on 17 December, 2013. Available from: http://water.epa.gov/scitech/swguidance/standards/current/index.cfm.

f United States Environmental Protection Agency (1999b) National recommended water quality criteria - correction. Document EPA 822-Z-99-001. Retrieved on 17 December, 2013. Available from: http://water.epa.gov/scitech/swguidance/standards/upload/2008_03_11_criteria_wqctable_1999table.pdf.

g Prairie Provinces Water Board (1992) Master Agreement on Apportionment. Schedule E: Agreement on Water Quality. Retrieved on 17 December, 2013. Available from: http://www.ppwb.ca/information/115/index.html.

New Brunswick

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	a
Arsenic	total	5 µg/L	b
Chloride	total	120 mg/L	b
Copper	total	2 µg/L for hardness < 90 mg $[CaCO_3]$/L $e^{0.8545*\ln[\text{hardness}]-1.465}*0.2$ µg/L for hardness > 90 mg $[CaCO_3]$/L where hardness as mg $[CaCO_3]$/L	a
Iron	total	0.3 mg/L	a
Nitrate	total	2.9 mg N/L	a
Oxygen	dissolved	6.5 mg/L	b
pH		between 6.5 and 9	b
Phosphorus	total	0.03 mg/L	a
Turbidity		10 NTU (SSG[1])	b
Zinc	total	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	a

[1] SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

New Brunswick Water Quality Guideline Sources:

a Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

b Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

Newfoundland and Labrador

Parameter	Form	Guideline	Source
Chloride	dissolved	120 mg/L	a
Copper	total	2 µg/L for hardness < 90 mg [$CaCO_3$]/L $e^{0.8545*ln[hardness]-1.465*0.2}$ for hardness > 90 mg/L where hardness as mg [$CaCO_3$]/L	b
Iron	total	SSG[1]	b c
Lead	total	$e^{1.273*ln[hardness]-4.705}$ µg/L where hardness as mg [$CaCO_3$]/L	b
Nickel	total	$e^{0.76[ln(hardness)]+1.06}$ µg/L where hardness as mg [$CaCO_3$]/L	b
Nitrate	total dissolved	3 mg N/L	b
Oxygen	dissolved	9.5 mg/L	a
pH		SSG[1]	c a
Phosphorus	total	0.03 mg/L	b
Zinc	total	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg/L where hardness as mg [$CaCO_3$]/L	b

[1] SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

Newfoundland and Labrador Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

c Khan AA *et al.* (2005) Application of CCME procedures for deriving site-specific water quality guidelines for the CCME Water Quality Index. *Water Quality Research Journal* 40(4):448-456.

Northwest Territories

Parameter	Form	Guideline	Source
Ammonia	un-ionized, dissolved	Lentic-lotic sites: 19 µg/L Lotic sites: SSG[1] (mean + 2 standard deviation)	a b
Arsenic	total	5 µg/L	c
Chloride	dissolved	Lentic-lotic sites: 120 mg/L Lotic sites: SSG[1] (mean + 2 standard deviation)	c b
Copper	total	Lentic-lotic sites: 2 µg/L for hardness < 90 mg $[CaCO_3]$/L $e^{0.8545*\ln[hardness]-1.465*0.2}$ for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L Lotic sites: SSG[1] (mean + 2 standard deviation)	a b
Iron	total	Lentic-lotic sites: 0.3 mg/L Lotic sites: SSG[1] (mean + 2 standard deviation)	a b
Lead	total	Lentic-lotic sites: $e^{1.273*\ln[hardness]-4.705}$ µg/L where hardness as mg $[CaCO_3]$/L Lotic sites: SSG[1] (mean + 2 standard deviation)	a b
Nitrate and nitrite	total dissolved	Lentic-lotic sites: 2.93 mg N/L Lotic sites: SSG[1] (mean + 2 standard deviation)	a b
Nitrite	dissolved	SSG[1] (mean + 2 standard deviation)	
Oxygen	dissolved	5 mg/L	c
pH		Lentic-lotic sites: between 6.5 and 9 Lotic sites: SSG[1] (mean + 2 standard deviation)	b c
Phosphorus	total	Lentic-lotic sites: 0.03 mg/L Lotic sites: SSG[1] (mean + 2 standard deviation)	a c
Zinc	total	Lentic-lotic sites: 30 µg/L Lotic sites: SSG[1] (mean + 2 standard deviation)	b c

[1] SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

Northwest Territories Water Quality Guideline Sources:

a Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

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c Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

Nova Scotia

Parameter	Form	Guideline	Source
Chloride	total	120 mg/L	a
Copper	extractable	2 µg/L for hardness < 90 mg $[CaCO_3]$/L $e^{0.8545*ln[hardness]-1.465*0.2}$ for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	b
Iron	extractable	0.3 mg/L	b
Lead	extractable	$e^{1.273*ln[hardness]-4.705}$ µg/L where hardness as mg $[CaCO_3]$/L	b
Nickel	total	$e^{0.76[ln(hardness)]+1.06}$ µg/L where hardness as mg $[CaCO_3]$/L	b
Nitrate	dissolved	3 mg N/L	b
Oxygen	dissolved	6.5 mg/L	a
pH		between 6.5 and 9	a
Phosphorus	total	0.03 mg/L	b
Zinc	extractable	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	b

Nova Scotia Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

Ontario

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	a b
Chloride	total	120 mg/L	a
Chromium	total	2 µg/L guideline for Cr(VI) adjusted to total chromium	a
Nickel	total	$e^{0.76*ln[hardness]+1.06}$ µg/L where hardness as mg $[CaCO_3]$/L	b
Nitrate	total dissolved	2.93 mg N/L	b
Phosphorus	total	0.03 mg/L	b c
Zinc	total	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	b

Ontario Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

c Ontario Ministry of the Environment and Energy (1994) Water management policies, guidelines, provincial water quality objectives. Retrieved on 17 December, 2013. Available from: https://archive.org/details/watermanagementp00ontauoft.

Prince Edward Island

Parameter	Form	Guideline	Source
Nitrate	total dissolved	3 mg N/L	a
Oxygen	dissolved	6.5 mg/L	b
pH		between 6.5 and 9	b
Phosphorus	total	0.03 mg/L SSG[1]	a
Suspended sediments	total	29 mg/L (SSG[1])	b

[1] SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

Prince Edward Island Water Quality Guideline Sources:

a Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

b Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

Quebec

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	c
Atrazine[1]		1.8 µg/L	c
Bentazone[1]		0.51 mg/L	a
Chlorophyll a		8 mg/L	d
Copper[1]	extractable	2 µg/L for hardness < 90 mg $[CaCO_3]$/L $e^{0.8545*ln[hardness]-1.465*0.2}$ for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	d
Dicamba[1]		10 µg/L	c
Metolachlor[1]	Metolachlor[1]	7.8 µg/L	c
Nickel[1]	total	$e^{0.76[ln(hardness)]+1.06}$ µg/L where hardness as mg $[CaCO_3]$/L	d
Nitrate and nitrite	total dissolved	3 mg N/L	c d
pH		between 6.5 and 9	a c
Phosphorus	total	0.03 mg/L	a
Turbidity		10 NTU	d
Zinc[1]	total	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75* (hardness-90) for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	d

[1] Only applies to sites monitored under federal monitoring programs.

Quebec Water Quality Guideline Sources:

a Ministère du Développement durable, Environnement et Parcs (2009) Critères de qualité de l'eau de surface. Retrieved on 17 December, 2013. Available from : http://www.mddep.gouv.qc.ca/eau/criteres_eau/index.asp (in French only).

b Nordin RN and Pommen LW (2001) Water quality criteria for nitrogen (nitrate, nitrite, and ammonia): Overview report. British Columbia Ministry of Environment and Parks. Retrieved on 17 December, 2013. Available from : http://www.env.gov.bc.ca/wat/wq/BCguidelines/nitrogen/nitrogen.html.

c Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from : http://st-ts.ccme.ca/.

d Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from : http://publications.gc.ca/pub?id=381540&sl=0.

Saskatchewan

Parameter	Form	Guideline	Source
2,4-D		4 µg/L	a
Ammonia	un-ionized	19 µg/L	b
Arsenic	total	5 µg/L	a
Chloride	dissolved	120 mg/L	a
Copper	total	2 µg/L for hardness < 90 mg $[CaCO_3]$/L $e^{0.8545*\ln[hardness]-1.465*0.2}$ µg/L for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	b
Lead	total	$e^{1.273*\ln[hardness]-4.705}$ µg/L where hardness as mg $[CaCO_3]$/L	b
MCPA		2.6 µg/L	a
Nickel	total	$e^{0.76*\ln[hardness]+1.06}$ µg/L where hardness as mg $[CaCO_3]$/L	b
Nitrogen	total	1 mg N/L	c
Oxygen	dissolved	6.5 mg/L	a
pH		between 6.5 and 9	a
Phosphorus	total	0.05 mg/L	c d
Zinc	total	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg/L where hardness as mg $[CaCO_3]$/L	b

Saskatchewan Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

c Alberta Environment (1999) Surface water quality guidelines for use in Alberta. Retrieved on 17 December, 2013. Available from: http://environment.alberta.ca/01323.html.

d Prairie Provinces Water Board (1992) Master Agreement on Apportionment. Schedule E: Agreement on Water Quality. Retrieved on 17 December, 2013. Available from: http://www.ppwb.ca/information/115/index.html.

Yukon

Parameter	Form	Guideline	Source
Arsenic	total	5 µg/L	a
Chromium	total	SSG[1]	b
Copper	total	2 µg/L for hardness < 90 mg [$CaCO_3$]/L $0.2e^{0.8545*ln[hardness]-1.465}$ for hardness > 90 mg/L where hardness as mg [$CaCO_3$]/L	c
Lead	total	1 µg/L for hardness < 50 mg [$CaCO_3$]/L, $e^{1.273*ln[hardness]-4.705}$ µg/L for hardness >50 mg [$CaCO_3$]/L	c
Nitrate	total dissolved	2.93 mg N/L	c
Nitrite	total	0.02 mg N/L	d
Nitrogen	dissolved	0.7 mg N/L	c
Oxygen	dissolved	8 mg/L	e
pH		between 6.5 and 9	a
Phosphorus	total	0.025 mg/L	c
Selenium	total	2 µg/L	c
Silver	total	0.05 µg/L for hardness < 100 mg/L 1.9 µg/L for hardness > 100 mg/L where hardness as mg [$CaCO_3$]/L	c
Temperature		SSG[1]	c
Zinc	total	7.5 µg/L for hardness ≤ 90 mg/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg/L where hardness as mg [$CaCO_3$]/L	c

[1] SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

Yukon Water Quality Guideline Sources:

a Canadian Council of Ministers of the Environment (2007) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1. Retrieved on 17 December, 2013. Available from: http://st-ts.ccme.ca/.

b Environment Canada (2005) Site-specific Water Quality Guidelines for the Liard River at Upper Crossing for the Purpose of National Reporting. Tri-Star Environmental Consulting. Retrieved on 17 December, 2013. Available from: http://waterquality.ec.gc.ca/WaterQualityWeb/PDFDocs/YT10AA0001%20-%20Liard%20at%20Upper%20Crossing.pdf.

c Government of Canada (2008) Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative. Environment Canada and Statistics Canada. Retrieved on 17 December, 2013. Available from: http://publications.gc.ca/pub?id=381540&sl=0.

d Nordin RN and Pommen LW (2001) Water quality criteria for nitrogen (nitrate, nitrite, and ammonia): Overview report. British Columbia Ministry of Environment and Parks. Retrieved on 17 December, 2013. Available from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/nitrogen/nitrogen.html.

e British Columbia Ministry of Environment (1997) Ambient Water Quality Criteria for Dissolved Oxygen. British Columbia Ministry of Environment, Water Management Branch. Victoria, BC.

www.ec.gc.ca

Additional information can be obtained at:
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